

What is Biomedical and Health Informatics?

William Hersh, MD

Professor and Chair

Department of Medical Informatics & Clinical Epidemiology

Oregon Health & Science University

Portland, OR, USA

Email: hersh@ohsu.edu

Web: www.billhersh.info

Blog: informaticsprofessor.blogspot.com

References

- Altman, R. and Klein, T. (2002). Challenges for biomedical informatics and pharmacogenomics. *Annual Review of Pharmacology and Toxicology*, 42: 113-133.
- Angrisano, C., Farrell, D., et al. (2007). Accounting for the Cost of Health Care in the United States. Washington, DC, McKinsey & Company.
http://www.mckinsey.com/mgi/rp/healthcare/accounting_cost_healthcare.asp.
- Anonymous (2003). Key Capabilities of an Electronic Health Record System. Washington, DC, National Academies Press. http://www.nap.edu/catalog.php?record_id=10781.
- Anonymous (2006). OECD Health Data 2006: Statistics and Indicators for 30 Countries. Paris, France, Organisation for Economic Co-operation and Development.
http://www.oecd.org/document/30/0,3343,en_2649_37407_12968734_1_1_1_37407,00.html.
- Anonymous (2008a). Information Behaviour of the Researcher of the Future. London, England, Centre for Information Behaviour and the Evaluation of Research.
<http://www.bl.uk/news/pdf/googlegen.pdf>.
- Anonymous (2008b). The State of Health Care Quality: 2008. Washington, DC, National Committee for Quality Assurance. http://www.ncqa.org/Portals/0/Newsroom/SOHC/SOHC_08.pdf.
- Anonymous (2009a). The American Reinvestment and Recovery Plan – By the Numbers. Washington, DC, White House.
http://www.whitehouse.gov/assets/Documents/Recovery_Plan_Metrics_Report_508.pdf.
- Anonymous (2009b). EHRVA Interoperability Roadmap. Chicago, IL, HIMSS Electronic Health Record Association.
http://www.himsssehra.org/docs/EHRA_InteroperabilityRoadmap_20090310_v3.pdf.
- Anonymous (2009c). Health Information Technology & Privacy. Philadelphia, PA, American College of Physicians.
http://www.acponline.org/advocacy/where_we_stand/health_information_technology/acphit.pdf.
- Anonymous (2009d). Medical Records and Health Information Technicians. Occupational Outlook Handbook, 2010-11 Edition. Washington, DC, Bureau of Labor Statistics.
<http://www.bls.gov/oco/ocoS103.htm>.
- Anonymous (2010a). Health Information Technology: Initial Set of Standards, Implementation Specifications, and Certification Criteria for Electronic Health Record Technology; Final Rule. Services, D. o. H. H. Washington, DC, Federal Register. 75: 44590-44654.
<http://edocket.access.gpo.gov/2010/pdf/2010-17210.pdf>.

- Anonymous (2010b). Medicare and Medicaid Programs; Electronic Health Record Incentive Program; Final Rule. Services, C. f. M. M. Washington, DC, Federal Register. 75: 44314-44485.
<http://edocket.access.gpo.gov/2010/pdf/2010-17207.pdf>.
- Ash, J., Berg, M., et al. (2004). Some unintended consequences of information technology in health care: the nature of patient care information system related errors. *Journal of the American Medical Informatics Association*, 11: 104-112.
- Attia, J., Ioannidis, J., et al. (2009a). How to use an article about genetic association: A: Background concepts. *Journal of the American Medical Association*, 301: 74-81.
- Attia, J., Ioannidis, J., et al. (2009b). How to use an article about genetic association: B: Are the results of the study valid? *Journal of the American Medical Association*, 301: 191-197.
- Attia, J., Ioannidis, J., et al. (2009c). How to use an article about genetic association: C: What are the results and will they help me in caring for my patients? *Journal of the American Medical Association*, 301: 304-308.
- Banks, J., Marmot, M., et al. (2006). Disease and disadvantage in the United States and in England. *Journal of the American Medical Association*, 295: 2037-2045.
- Benson, T. (2010). *Principles of Health Interoperability HL7 and SNOMED*. New York, NY. Springer.
- Bernstam, E., Hersh, W., et al. (2009). Synergies and distinctions between computational disciplines in biomedical research: perspective from the Clinical and Translational Science Award programs. *Academic Medicine*, 84: 964-970.
- Berwick, D., James, B., et al. (2003). Connections between quality measurement and improvement. *Medical Care*, 41: I-30-I-38.
- Bier, F., vonNickisch-Roseneck, M., et al. (2008). DNA microarrays. *Advances in Biochemical Engineering/Biotechnology*, 109: 433-453.
- Björk, B., Welling, P., et al. (2010). Open access to the scientific journal literature: situation 2009. *PLoS ONE*, 5(6): e11273.
- Blumenthal, D. (2010). Launching HITECH. *New England Journal of Medicine*, 362: 382-385.
- Blumenthal, D. and Tavenner, M. (2010). The "meaningful use" regulation for electronic health records. *New England Journal of Medicine*, 363: 501-504.
- Bourgeois, F., Olson, K., et al. (2010). Patients treated at multiple acute health care facilities: quantifying information fragmentation. *Archives of Internal Medicine*, 170: 1989-1995.
- Brailer, D. (2005). Interoperability: the key to the future health care system. *Health Affairs*, 24: W5-19-W5-21.
- Brailer, D. (2007). From Santa Barbara to Washington: a person's and a nation's journey toward portable health information. *Health Affairs*, 26: w581-w588.
- Brown, S., Lincoln, M., et al. (2003). Vista-U.S. Department of Veterans Affairs national-scale HIS. *International Journal of Medical Informatics*, 69: 135-156.
- Buntin, M., Burke, M., et al. (2011). The benefits of health information technology: a review of the recent literature shows predominantly positive results. *Health Affairs*, 30: 464-471.
- Carter, J. (2008). *Electronic Health Records, A Guide for Clinicians and Administrators, Second Edition*. Philadelphia, PA. American College of Physicians.
- Chantler, S. (1999). The role and education of doctors in the delivery of health care. *Lancet*, 353: 1178-1181.
- Chapman, W., Nadkarni, P., et al. (2011). Overcoming barriers to NLP for clinical text: the role of shared tasks and the need for additional creative solutions *Journal of the American Medical Informatics Association*, 18: 540-543.
- Chaudhry, B., Wang, J., et al. (2006). Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine*, 144: 742-752.

- Chen, W., Hayward, C., et al. (2011). Copy number variation across European populations. *PLoS ONE*, 6(8): e23087.
- Chin, L. and Gray, J. (2008). Translating insights from the cancer genome into clinical practice. *Nature*, 452: 553-563.
- Cohen, A. and Hersh, W. (2005). A survey of current work in biomedical text mining. *Briefings in Bioinformatics*, 6: 57-71.
- Cohen, A., Stavri, P., et al. (2004). A categorization and analysis of the criticisms of evidence-based medicine. *International Journal of Medical Informatics*, 73: 35-43.
- Coiera, E. (2007). Putting the technical back into socio-technical systems research. *International Journal of Medical Informatics*, 76(Supp 1): 98-103.
- Collen, M. (1994). The origins of informatics. *Journal of the American Medical Informatics Association*, 1: 91-107.
- Collins, F. (2010). *The Language of Life: DNA and the Revolution in Personalized Medicine*. New York, NY. Harper.
- Conn, J. (2007). Oregon RHIO planning efforts come to a halt. *Modern Healthcare*. August 29, 2007.
- Conn, J. (2008). Perot Systems lands VistA contract in Middle East. *Modern Healthcare*. July 29, 2008.
- Conn, J. (2009a). Groups deemed IT leaders 'fall far short' of IOM goals. *Modern Healthcare*. January 22, 2009.
- Conn, J. (2009b). Use available IT to take little steps, Stead advises. *Modern Healthcare*. January 23, 2009.
- Cowin, P., Anglesio, M., et al. (2010). Profiling the cancer genome. *Annual Review of Genomics and Human Genetics*, 11: 133-159.
- Cusack, C., Pan, E., et al. (2007). The Value of Provider-to-Provider Telehealth Technologies. Boston, MA, Center for Information Technology Leadership.
http://www.citl.org/pdf/CITL_Telehealth_Report.pdf.
- Daigrepont, J. and McGrath, D. (2011). *Complete Guide and Toolkit to Successful EHR Adoption*. Chicago, IL. Healthcare Information and Management Systems Society.
- Darkins, A., Ryan, P., et al. (2008). Care Coordination/Home Telehealth: the systematic implementation of health informatics, home telehealth, and disease management to support the care of veteran patients with chronic conditions. *Telemedicine and e-Health*, 14: 1118-1126.
- Dawes, M., Summerskill, W., et al. (2005). Sicily statement on evidence-based practice. *BMC Medical Education*, 5(1): 1.
- DelBeccaro, M., Jeffries, H., et al. (2006). Computerized provider order entry implementation: no association with increased mortality rates in an intensive care unit. *Pediatrics*, 118: 290-295.
- Denny, J., Peterson, J., et al. (2010). Extracting timing and status descriptors for colonoscopy testing from electronic medical records. *Journal of the American Medical Informatics Association*, 17: 383-388.
- Denny, J., Ritchie, M., et al. (2010). Identification of genomic predictors of atrioventricular conduction: using electronic medical records as a tool for genome science. *Circulation*, 122: 2016-2021.
- Detmer, D., Munger, B., et al. (2010). Clinical informatics board certification: history, current status, and predicted impact on the medical informatics workforce. *Applied Clinical Informatics*, 1: 11-18.
- Dimick, C. (2008). HIM jobs of tomorrow. *Journal of AHIMA*, 79(10): 26-34.
- Durinck, S., Ho, C., et al. (2011). Temporal dissection of tumorigenesis in primary cancers. *Cancer Discovery*, 1: 137-143.
- Ekeland, A., Bowes, A., et al. (2010). Effectiveness of telemedicine: a systematic review of reviews. *International Journal of Medical Informatics*, 79: 736-771.
- Embi, P. and Payne, P. (2009). Clinical research informatics: challenges, opportunities and definition for an emerging domain. *Journal of the American Medical Informatics Association*, 16: 316-327.

- Feldman, S. and Hersh, W. (2008). Evaluating the AMIA-OHSU 10x10 program to train healthcare professionals in medical informatics. *AMIA Annual Symposium Proceedings*, Washington, DC. American Medical Informatics Association. 182-186.
- Field, M. and Grigsby, J. (2002). Telemedicine and remote patient monitoring. *Journal of the American Medical Association*, 288: 423-425.
- Finnell, J., Overhage, J., et al. (2011). All health care is not local: an evaluation of the distribution of emergency department care delivered in Indiana. *AMIA Annual Symposium Proceedings*, Washington, DC. in press.
- Fox, S. (2011). Health topics. Washington, DC, Pew Internet & American Life Project.
http://www.pewinternet.org/~media/Files/Reports/2011/PIP_HealthTopics.pdf.
- Friedman, C. (2007). Building the Workforce: An Imperative for Public Health Informatics. Atlanta, GA, Public Health Information Network (PHIN) 2007 Keynote Address.
- Friedman, C. (2008). Building the Health Informatics Workforce. Sacramento, CA, University of California Davis Invited Presentation.
- Friedman, C. (2009). A 'fundamental theorem' of biomedical informatics. *Journal of the American Medical Informatics Association*, 16: 169-170.
- Friedman, C., Wong, A., et al. (2010). Achieving a nationwide learning health system. *Science Translational Medicine*, 2(57): 57cm29.
- Gardner, R., Overhage, J., et al. (2009). Core content for the subspecialty of clinical informatics. *Journal of the American Medical Informatics Association*, 16: 153-157.
- Gibson, G. and Muse, S. (2009). *A Primer of Genome Science, Third Edition*. Sunderland, MA. Sinauer Associates Publishers.
- Goldzweig, C., Towfigh, A., et al. (2009). Costs and benefits of health information technology: new trends from the literature. *Health Affairs*, 28: w282-w293.
- Goroll, A., Simon, S., et al. (2009). Community-wide implementation of health information technology: the Massachusetts eHealth Collaborative experience. *Journal of the American Medical Informatics Association*, 16: 132-139.
- Greenfield, S. and Kaplan, S. (2004). Creating a culture of quality: the remarkable transformation of the Department of Veterans Affairs Health Care System. *Annals of Internal Medicine*, 141: 316-318.
- Greiner, A. and Knebel, E., eds. (2003). *Health Professions Education: A Bridge to Quality*. Washington, DC. National Academies Press.
- Gugerty, B. and Delaney, C. (2009). TIGER Informatics Competencies Collaborative (TICC) Final Report, Technology Informatics Guiding Educational Reform (TIGER) Initiative.
http://tigercompetencies.pbworks.com/f/TICC_Final.pdf.
- Guyatt, G., Rennie, D., et al. (2008a). *Users' Guides to the Medical Literature: A Manual for Evidence-Based Clinical Practice*. New York, NY. McGraw-Hill.
- Guyatt, G., Rennie, D., et al. (2008b). *Users' Guides to the Medical Literature: Essentials of Evidence-Based Clinical Practice*. New York, NY. McGraw-Hill.
- Halamka, J., Aranow, M., et al. (2005). Health care IT collaboration in Massachusetts: the experience of creating regional connectivity. *Journal of the American Medical Informatics Association*, 12: 596-601.
- Hamburg, M. and Collins, F. (2010). The path to personalized medicine. *New England Journal of Medicine*, 363: 301-304.
- Han, Y., Carcillo, J., et al. (2005). Unexpected increased mortality after implementation of a commercially sold computerized physician order entry system. *Pediatrics*, 116: 1506-1512.
- Hanahan, D. and Weinberg, R. (2011). Hallmarks of cancer: the next generation. *Cell*, 144: 646-674.
- Hardy, J. and Singleton, A. (2009). Genomewide association studies and human disease. *New England Journal of Medicine*, 360: 1759-1768.

- Hasman, A., Haux, R., et al. (1996). A systematic view on medical informatics. *Computer Methods and Programs in Biomedicine*, 51: 131-139.
- Hayes, G. and Barnett, D. (2008). *UK Health Computing: Recollections and Reflections*. Swindon, UK. British Computer Society.
- Haynes, R. (2001). Of studies, syntheses, synopses, and systems: the "4S" evolution of services for finding current best evidence. *ACP Journal Club*, 134: A11-A13.
- Haynes, R. (2002). What kind of evidence is it that Evidence-Based Medicine advocates want health care providers and consumers to pay attention to? *BMC Health Services Research*, 2: 3.
- Hersh, W. (2001). The way of the future? Review of Biomed Central. *Nature*, 413: 680.
- Hersh, W. (2002). Medical informatics - improving health care through information. *Journal of the American Medical Association*, 288: 1955-1958.
- Hersh, W. (2004). Health care information technology: progress and barriers. *Journal of the American Medical Association*, 292: 2273-2274.
- Hersh, W. (2005). *The Full Spectrum of Biomedical Informatics Research and Education at OHSU*, 204-209, in Haux, R. and Kulikowski, C., eds. *Yearbook of Medical Informatics 2005*. Stuttgart, Germany. Schattauer.
- Hersh, W. (2006). Who are the informaticians? What we know and should know. *Journal of the American Medical Informatics Association*, 13: 166-170.
- Hersh, W. (2007). The full spectrum of biomedical informatics education at Oregon Health & Science University. *Methods of Information in Medicine*, 46: 80-83.
- Hersh, W. (2008a). *Health and Biomedical Informatics: Opportunities and Challenges for a Twenty-First Century Profession and its Education*, 138-145, in Geissbuhler, A. and Kulikowski, C., eds. *IMIA Yearbook of Medical Informatics 2008*. Stuttgart, Germany. Schattauer.
- Hersh, W. (2008b). Ubiquitous but unfinished: grand challenges for information retrieval. *Health Information and Libraries Journal*, 25(Suppl 1): 90-93.
- Hersh, W. (2009a). *Information Retrieval: A Health and Biomedical Perspective (3rd Edition)*. New York, NY. Springer.
- Hersh, W. (2009b). A stimulus to define informatics and health information technology. *BMC Medical Informatics & Decision Making*, 9: 24.
- Hersh, W. (2010). The health information technology workforce: estimations of demands and a framework for requirements. *Applied Clinical Informatics*, 1: 197-212.
- Hersh, W., Hickam, D., et al. (2006). Diagnosis, access, and outcomes: update of a systematic review on telemedicine services. *Journal of Telemedicine & Telecare*, 12(Suppl 2): 3-31.
- Hersh, W., Junium, K., et al. (2001). Implementation and evaluation of a medical informatics distance education program. *Journal of the American Medical Informatics Association*, 8: 570-584.
- Hersh, W. and Wright, A. (2008). What workforce is needed to implement the health information technology agenda? An analysis from the HIMSS Analytics™ Database. *AMIA Annual Symposium Proceedings*, Washington, DC. American Medical Informatics Association. 303-307.
- Hogge, L., Yadrick, M., et al. (2010). A decade of work coming together: nutrition care, electronic health records, and the HITECH Act. *Journal of the American Dietetic Association*, 110: 1606-1614.
- Hsiao, C., Beatty, P., et al. (2010). Electronic Medical Record/Electronic Health Record Systems of Office-based Physicians: United States, 2009 and Preliminary 2010 State Estimates. Hyattsville, MD, National Center for Health Statistics.
http://www.cdc.gov/nchs/data/hestat/emr_ehr_09/emr_ehr_09.htm.
- Jacobs, B., Brill, R., et al. (2006). Perceived increase in mortality after process and policy changes implemented with computerized physician order entry. *Pediatrics*, 117: 1451-1452.
- Jha, A., DesRoches, C., et al. (2010). A progress report on electronic health records in U.S. hospitals. *Health Affairs*, 29: 1951-1957.

- Johnson, G. (2011). Cancer's Secrets Come Into Sharper Focus. *New York Times*. August 15, 2011.
- Johnston, D., Pan, E., et al. (2003). The Value of Computerized Provider Order Entry in Ambulatory Settings. Boston, MA, Center for Information Technology Leadership.
- Kohane, I. (2009). The twin questions of personalized medicine: who are you and whom do you most resemble? *Genome Medicine*, 1: 4.
- Kohane, I., Masys, D., et al. (2006). The incidentalome: a threat to genomic medicine. *Journal of the American Medical Association*, 296: 212-215.
- Kohn, L., Corrigan, J., et al., eds. (2000). *To Err Is Human: Building a Safer Health System*. Washington, DC. National Academies Press.
- Koppel, R., Metlay, J., et al. (2005). Role of computerized physician order entry systems in facilitating medication errors. *Journal of the American Medical Association*, 293: 1197-1203.
- Krallinger, M., Valencia, A., et al. (2008). Linking genes to literature: text mining, information extraction, and retrieval applications for biology. *Genome Biology*, 9: S8.
- Kuperman, G. (2011). Health-information exchange: why are we doing it, and what are we doing? *Journal of the American Medical Informatics Association*, 18: 678-682.
- Lasser, K., Himmelstein, D., et al. (2006). Access to care, health status, and health disparities in the United States and Canada: results of a cross-national population-based survey. *American Journal of Public Health*, 96: 1300-1307.
- Leviss, J., Gugerty, B., et al. (2010). *H.I.T. or Miss: Lessons Learned from Health Information Technology Implementations*. Chicago, IL. American Health Information Management Association.
- Leviss, J., Kremsdorf, R., et al. (2006). The CMIO - a new leader for health systems. *Journal of the American Medical Informatics Association*, 13: 573-578.
- Liang, L. (2010). *Connected for Health - Using Electronic Health Records to Transform Care Delivery*. San Francisco, CA. Jossey-Bass.
- Luce, B., Kramer, J., et al. (2009). Rethinking randomized clinical trials for comparative effectiveness research: the need for transformational change. *Annals of Internal Medicine*, 151: 206-209.
- Lupski, J. (2007). Structural variation in the human genome. *New England Journal of Medicine*, 356: 1169-1171.
- Mantas, J., Ammenwerth, E., et al. (2010). Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics - 1st revision. *Methods of Information in Medicine*, 49: 105-120.
- McCambridge, M., Jones, K., et al. (2010). Association of health information technology and teleintensivist coverage with decreased mortality and ventilator use in critically ill patients. *Archives of Internal Medicine*, 170: 648-653.
- McCarty, C., Chisholm, R., et al. (2010). The eMERGE Network: a consortium of biorepositories linked to electronic medical records data for conducting genomic studies. *BMC Genomics*, 4(1): 13.
- McDonald, C., Overhage, J., et al. (2005). The Indiana Network for Patient Care: a working local health information infrastructure. *Health Affairs*, 24: 1214-1220.
- McGinnis, J., Olsen, L., et al. (2007). Learning What Works Best: The Nations Need for Evidence on Comparative Effectiveness in Health Care. Washington, DC, Institute of Medicine.
[http://www.iom.edu/Object.File/Master/57/393/Comparative%20Effectiveness%20White%20Paper%20\(F\).pdf](http://www.iom.edu/Object.File/Master/57/393/Comparative%20Effectiveness%20White%20Paper%20(F).pdf).
- McGlynn, E., Asch, S., et al. (2003). The quality of health care delivered to adults in the United States. *New England Journal of Medicine*, 348: 2635-2645.
- McGraw, D., Dempsey, J., et al. (2009). Privacy as an enabler, not an impediment: building trust into health information exchange. *Health Affairs*, 28: 416-427.
- Meyerson, M., Gabriel, S., et al. (2010). Advances in understanding cancer genomes through second-generation sequencing. *Nature Reviews Genetics*, 11: 685-696.

- Miller, R. and Miller, B. (2007). The Santa Barbara County Care Data Exchange: what happened? *Health Affairs*, 26: w568-w580.
- Miller, R., West, C., et al. (2005). The value of electronic health records in solo or small group practices. *Health Affairs*, 24: 1127-1137.
- Moehr, J. (2004). *The Quest for Identity of Medical Informatics, and for Guidance to Education in it: the German Conference at the Reisenburg of 1973 revisited*, 200-209, in Haux, R., McCray, A. and Kullikowski, C., eds. *Yearbook of Medical Informatics 2004*. Stuttgart, Germany. Schattauer.
- Murray, R. and McElwee, N. (2010). Comparative effectiveness research: critically intertwined with health care reform and the future of biomedical innovation. *Archives of Internal Medicine*, 170: 596-599.
- Nadkarni, P., Ohno-Machado, L., et al. (2011). Natural language processing: an introduction. *Journal of the American Medical Informatics Association*, 18: 544-551.
- Nass, S., Levit, L., et al., eds. (2009). *Beyond the HIPAA Privacy Rule: Enhancing Privacy, Improving Health Through Research*. Washington, DC. National Academies Press.
- Nemko, M. (2007). Ahead-of-the-Curve Careers. US News & World Report. December 19, 2007.
- Ness, R. (2007). Influence of the HIPAA Privacy Rule on health research. *Journal of the American Medical Association*, 298: 2164-2170.
- Otero, P., Hersh, W., et al. (2010). A medical informatics distance-learning course for Latin America - translation, implementation and evaluation. *Methods of Information in Medicine*, 49: 310-315.
- Overhage, J., Perkins, S., et al. (2001). Controlled trial of direct physician order entry: effects on physicians' time utilization in ambulatory primary care internal medicine practices. *Journal of the American Medical Informatics Association*, 8: 361-371.
- Pathak, J., Wang, J., et al. (2011). Mapping clinical phenotype data elements to standardized metadata repositories and controlled terminologies: the eMERGE Network experience. *Journal of the American Medical Informatics Association*, 18: 376-386.
- Phibbs, C., Milstein, A., et al. (2005). No proven link between CPOE and mortality. *Pediatrics*.
- Protti, D. and Johansen, I. (2010). Widespread Adoption of Information Technology in Primary Care Physician Offices in Denmark: A Case Study. New York, NY, Commonwealth Fund.
http://www.commonwealthfund.org/~media/Files/Publications/Issue%20Brief/2010/Mar/137_9_Protti_widespread_adoption_IT_primary_care_Denmark_intl_ib.pdf.
- Redon, R., Ishikawa, S., et al. (2006). Global variation in copy number in the human genome. *Nature*, 444: 444-454.
- Rosenbloom, S., Geissbuhler, A., et al. (2005). Effect of CPOE user interface design on user-initiated access to educational and patient information during clinical care. *Journal of the American Medical Informatics Association*, 12: 458-473.
- Safran, C., Bloomrosen, M., et al. (2007). Toward a national framework for the secondary use of health data: an American Medical Informatics Association white paper. *Journal of the American Medical Informatics Association*, 14: 1-9.
- Safran, C. and Detmer, D. (2005). Computerized physician order entry systems and medication errors. *Journal of the American Medical Association*, 294: 179.
- Safran, C., Shabot, M., et al. (2009). ACGME program requirements for fellowship education in the subspecialty of clinical informatics. *Journal of the American Medical Informatics Association*, 16: 158-166.
- Samuels, C. (2008). *Workflow*, 453-472, in Carter, J., ed. *Electronic Health Records, A Guide for Clinicians and Administrators, Second Edition*. Philadelphia, PA. American College of Physicians.
- Sarkar, I., Butte, A., et al. (2011). Translational bioinformatics: linking knowledge across biological and clinical realms. *Journal of the American Medical Informatics Association*, 18: 354-357.

- Schoen, C., Osborn, R., et al. (2009a). A survey of primary care physicians in eleven countries, 2009: perspectives on care, costs, and experiences. *Health Affairs*, 28: w1171-1183.
- Schoen, C., Osborn, R., et al. (2009b). In chronic condition: experiences of patients with complex health care needs, in eight countries, 2008. *Health Affairs*, 28: w1-w16.
- Schulte, M., ed. (2011). *Go-Live: Smart Strategies from Davies Award-Winning EHR Implementations*. Chicago, IL. Healthcare Information Management Systems Society.
- Shaffer, V. and Lovelock, J. (2010). Results of the Gartner-AMDIS Survey of Chief Medical Informatics Officers. Stamford, CT, Gartner.
- Shea, S., Weinstock, R., et al. (2006). A randomized trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus. *Journal of the American Medical Informatics Association*, 13: 40-51.
- Sittig, D., Ash, J., et al. (2006). Lessons from "unexpected increased mortality after implementation of a commercially sold computerized physician order entry system". *Pediatrics*, 118: 797-801.
- Sittig, D. and Singh, H. (2011). Defining health information technology-related errors: new developments since to err is human. *Archives of Internal Medicine*, 171: 1281-1284.
- Slawson, D. and Shaughnessy, A. (2005). Teaching evidence-based medicine: should we be teaching information management instead? *Academic Medicine*, 80: 685-689.
- Smith, P., Araya-Guerra, R., et al. (2005). Missing clinical information during primary care visits. *Journal of the American Medical Association*, 293: 565-571.
- Stanfill, M., Williams, M., et al. (2010). A systematic literature review of automated clinical coding and classification systems. *Journal of the American Medical Informatics Association*, 17: 646-651.
- Stark, P. (2010). Congressional intent for the HITECH Act. *American Journal of Managed Care*, 16: SP24-SP28.
- Stead, W. and Lin, H., eds. (2009). *Computational Technology for Effective Health Care: Immediate Steps and Strategic Directions*. Washington, DC. National Academies Press.
- Stead, W., Searle, J., et al. (2010). Biomedical informatics: changing what physicians need to know and how they learn. *Academic Medicine*: Epub ahead of print.
- Straus, S., Richardson, W., et al. (2005). *Evidence Based Medicine: How to Practice and Teach EBM, Third Edition*. New York, NY. Churchill Livingstone.
- Thorn, C., Klein, T., et al. (2010). Pharmacogenomics and bioinformatics: PharmGKB. *Pharmacogenomics*, 11: 501-505.
- Tunis, S., Stryer, D., et al. (2003). Practical clinical trials - increasing the value of clinical research for decision making in clinical and health policy. *Journal of the American Medical Association*, 290: 1624-1632.
- VanDenBos, J., Rustagi, K., et al. (2011). The \$17.1 billion problem: the annual cost Of measurable medical errors. *Health Affairs*, 30: 596-603.
- Wilhelm, C. and Dixon-Lee, C. (2007). A new blueprint for HIM education. *Journal of AHIMA*, 78(8): 24-28.
- Wilke, R., Xu, H., et al. (2011). The emerging role of electronic medical records in pharmacogenomics. *Clinical Pharmacology and Therapeutics*, 89: 379-386.
- Wilson, K. (2011). Health Care Costs 101. Oakland, CA, California Health Care Foundation. <http://www.chcf.org/publications/2011/05/health-care-costs-101>.
- Zerhouni, E. (2007). Translational research: moving discovery to practice. *Clinical Pharmacology and Therapeutics*, 81: 126-128.